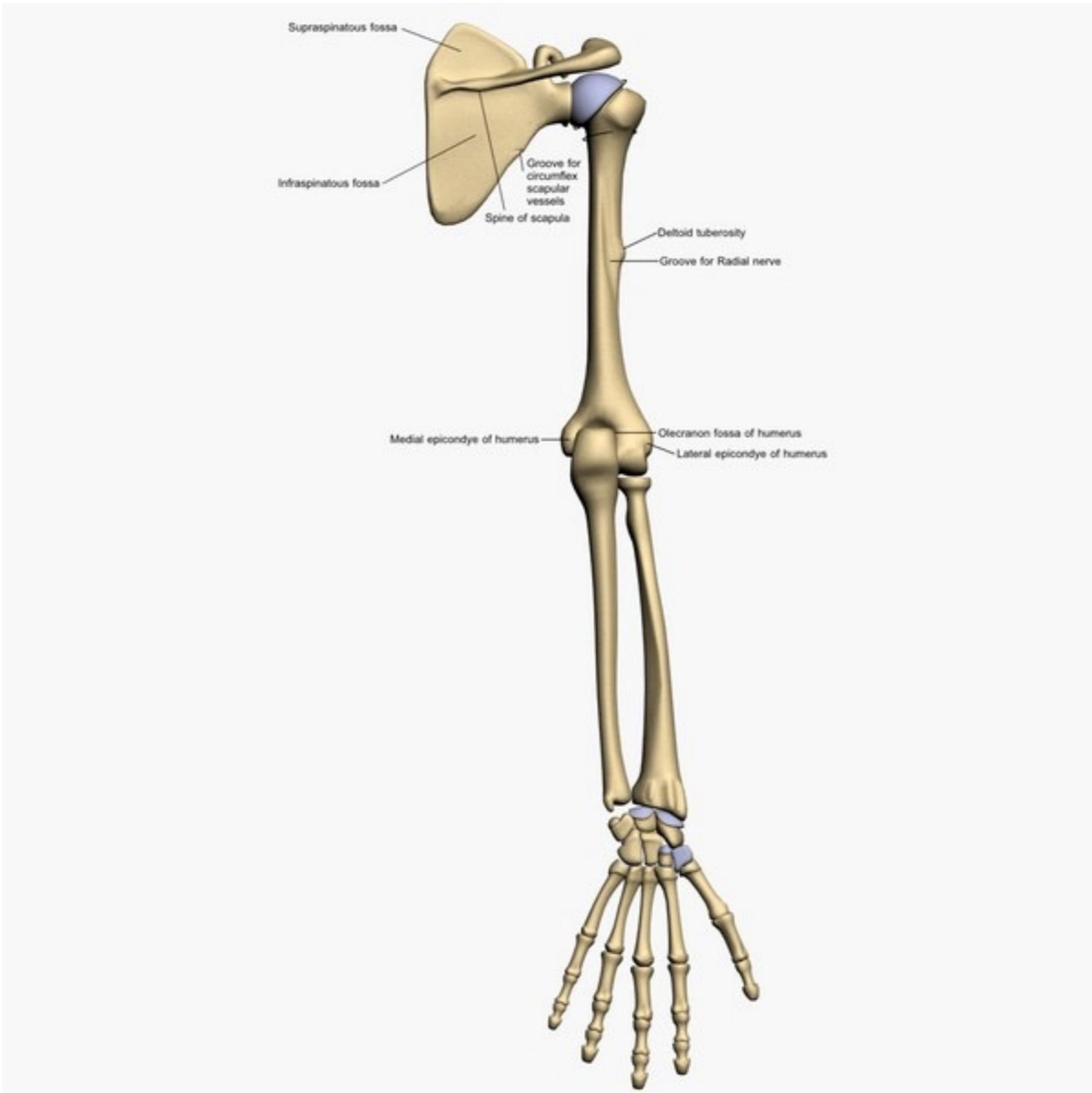


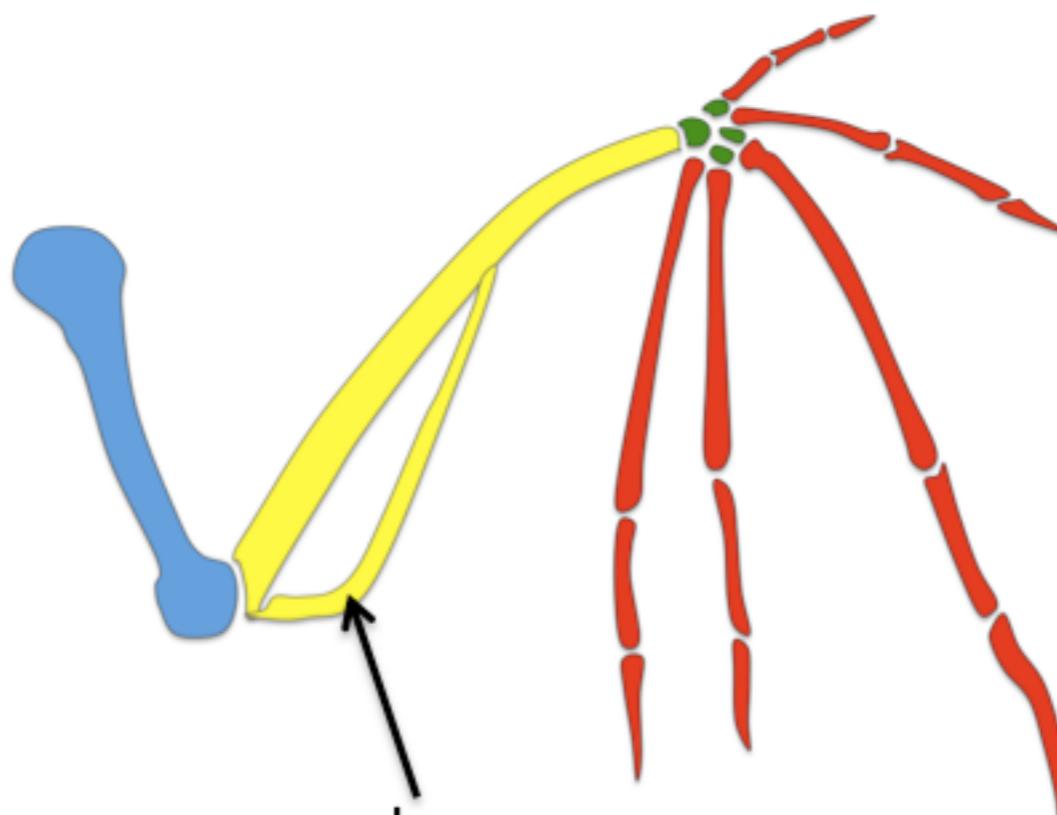
How do we learn about the origin of herps?

- Study relationships among living species
- Find and analyze fossils
- Understand genetics and development

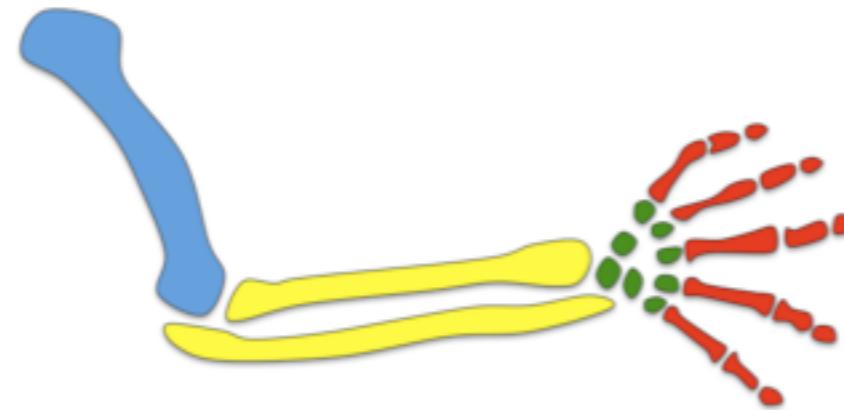


bat skeletal forelimb

stylopod 
zeugopod 
autopod 



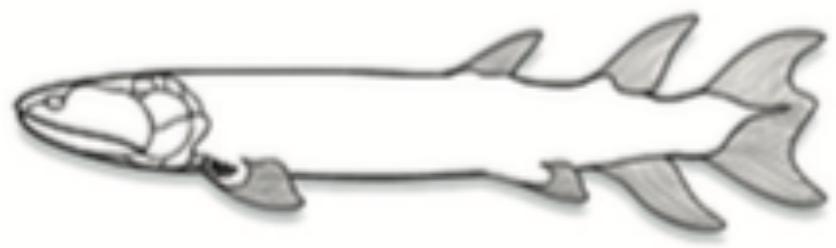
mouse skeletal forelimb



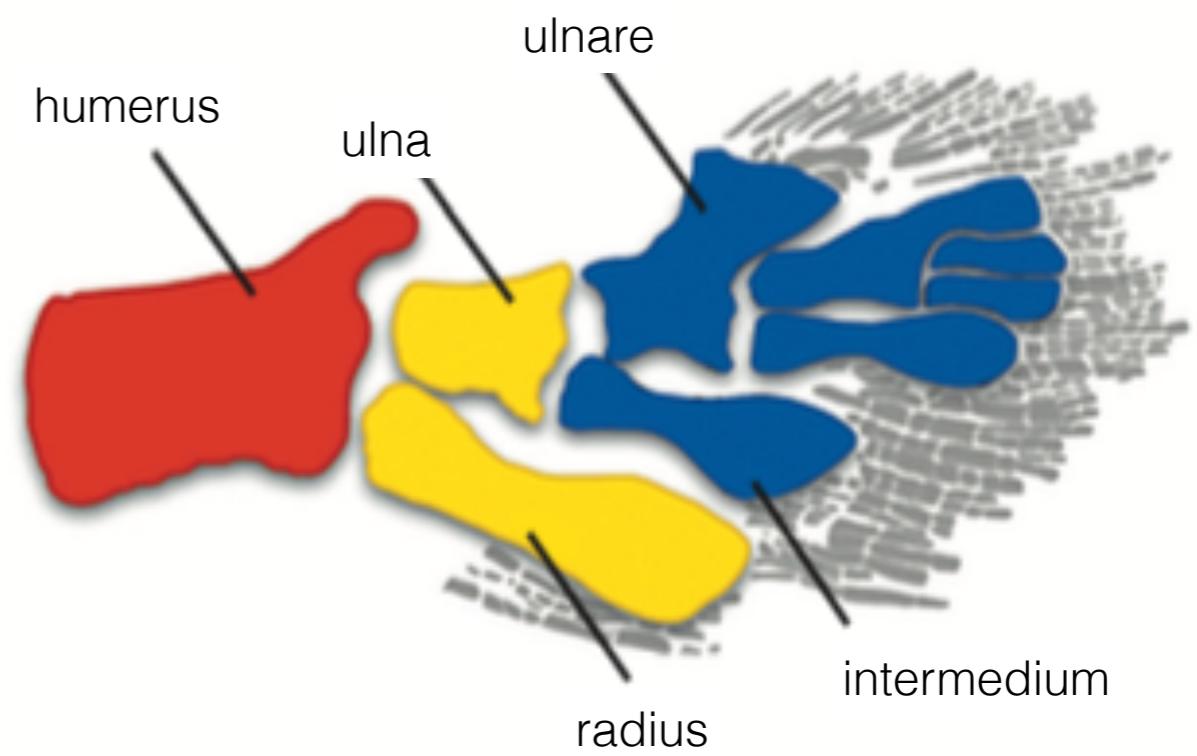
Endochondral
bones

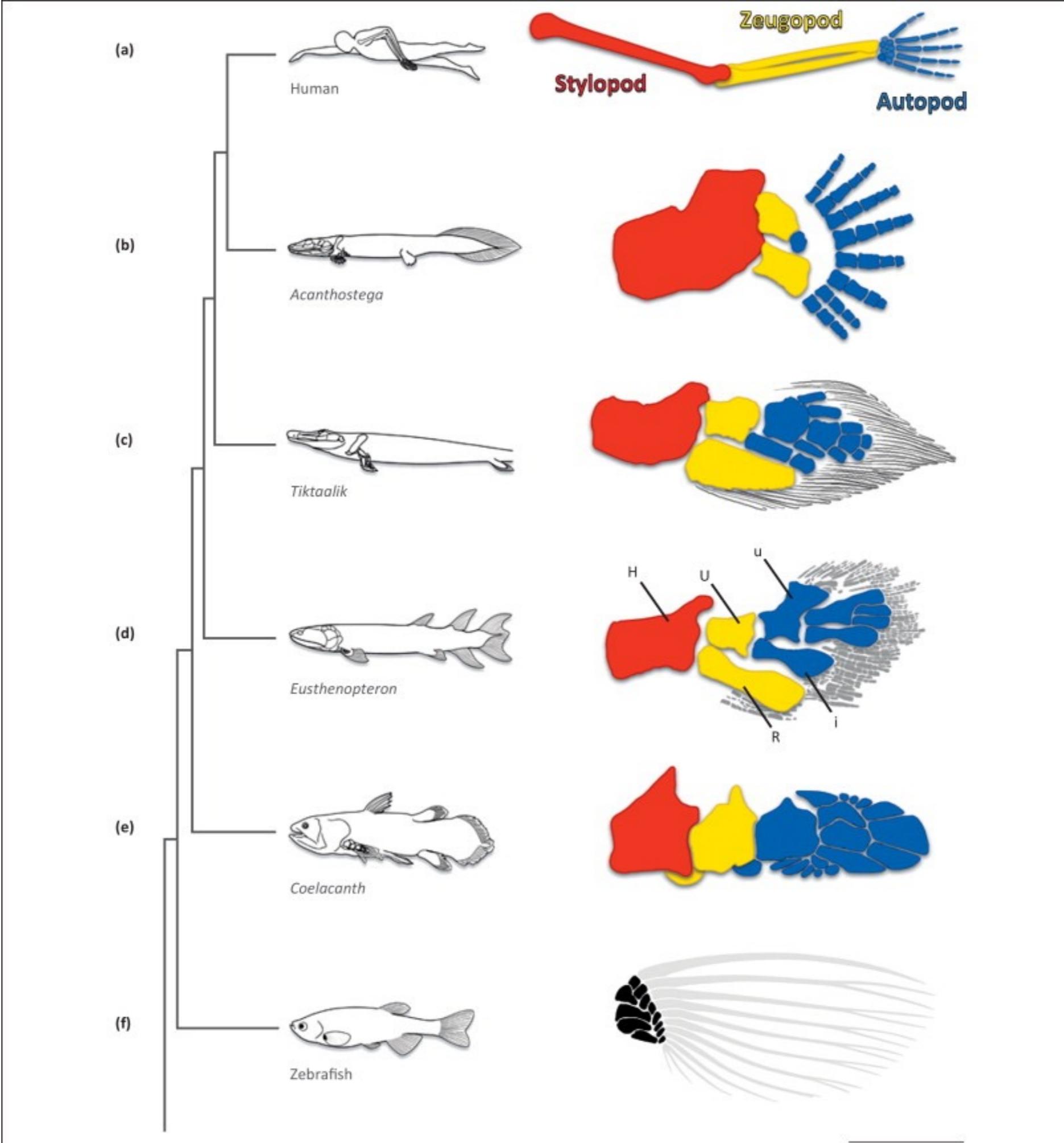


Fin rays
(dermal bones)



Eusthenopteron

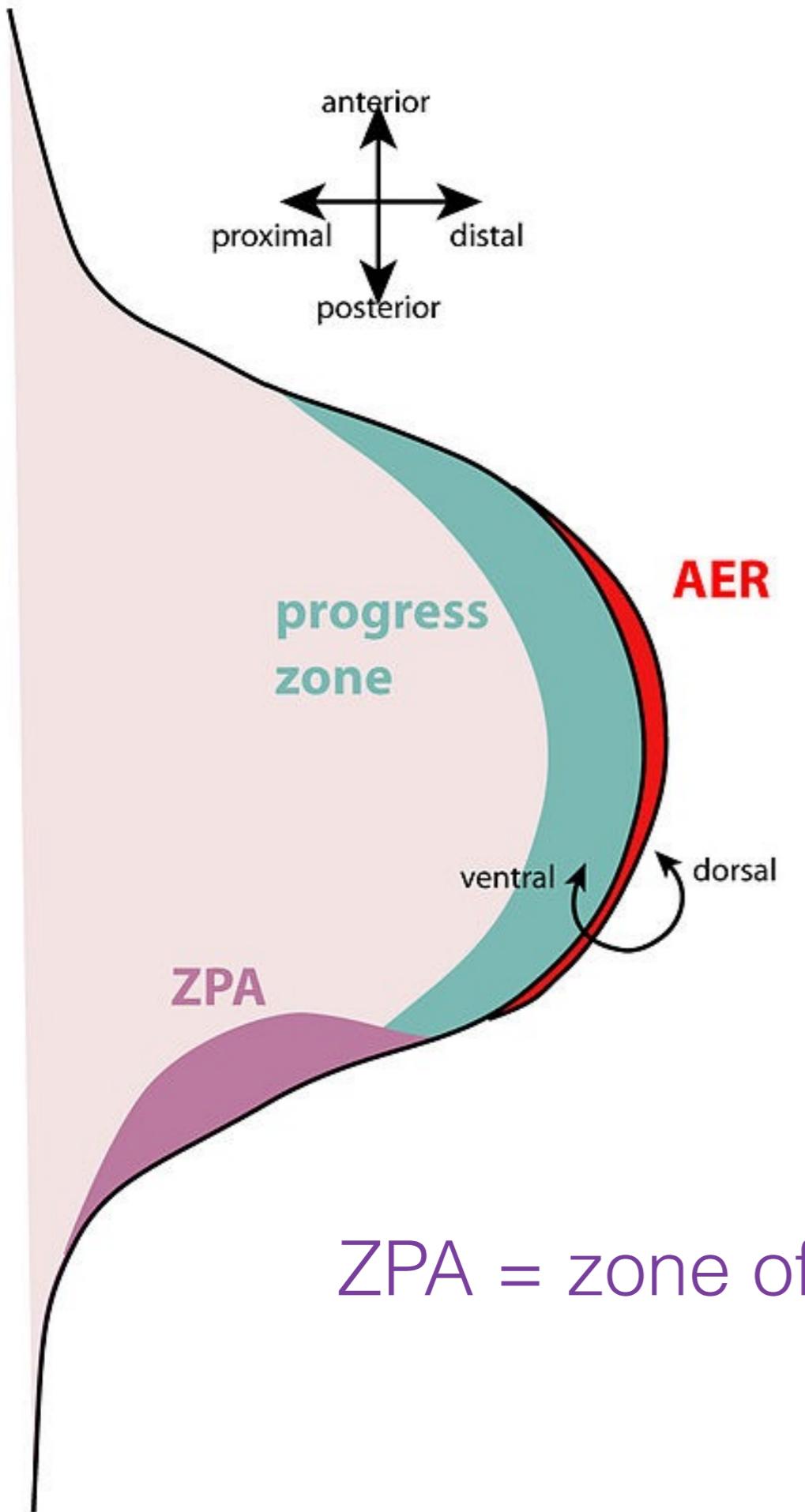




How did this transition occur?

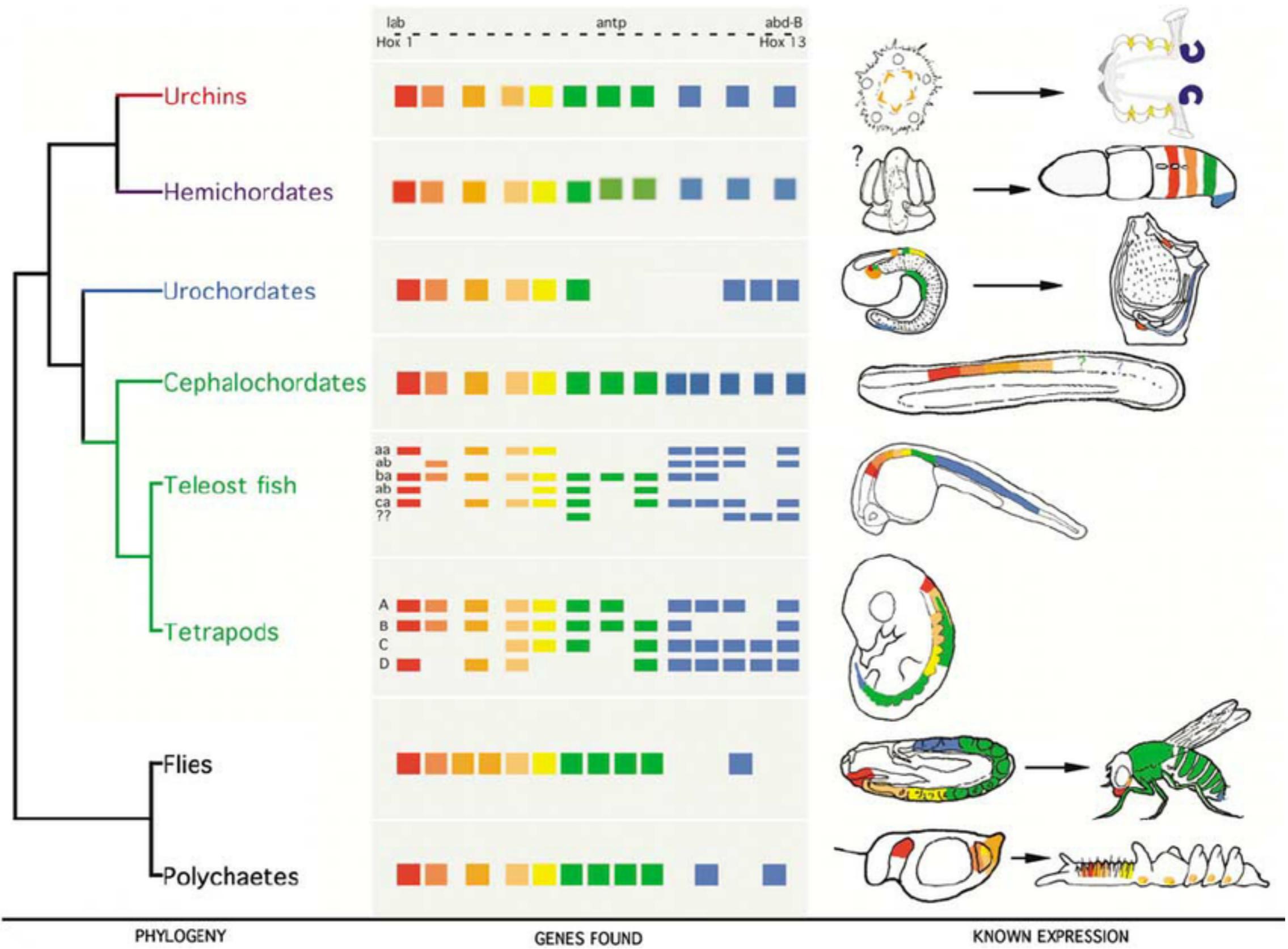
AER = Apical ectodermal ridge

critical part of the formation of limb buds



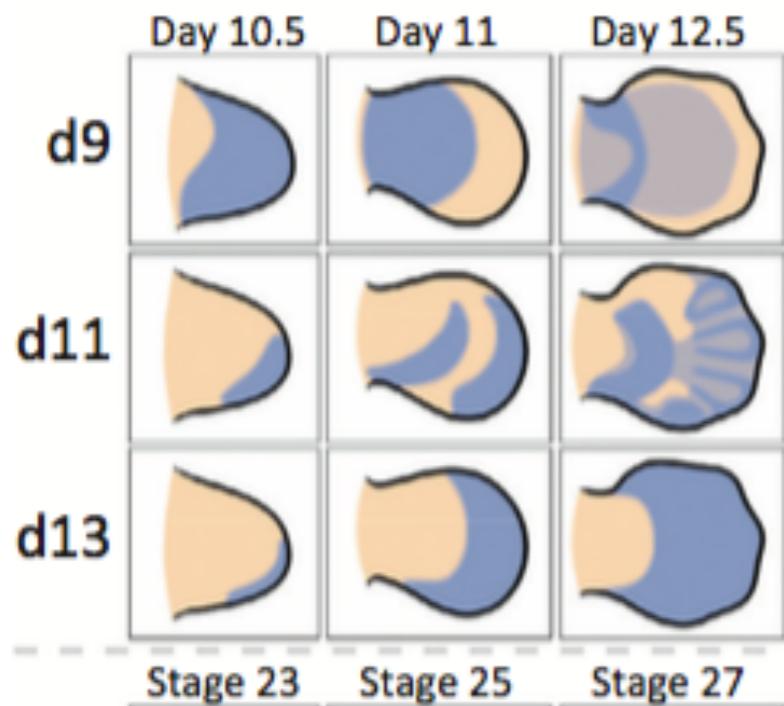
ZPA = zone of polarizing activity

The **pattern and timing of Hox gene expression** determines limb segments and their relation to one another



Focus of this paper: Hox13 A and D

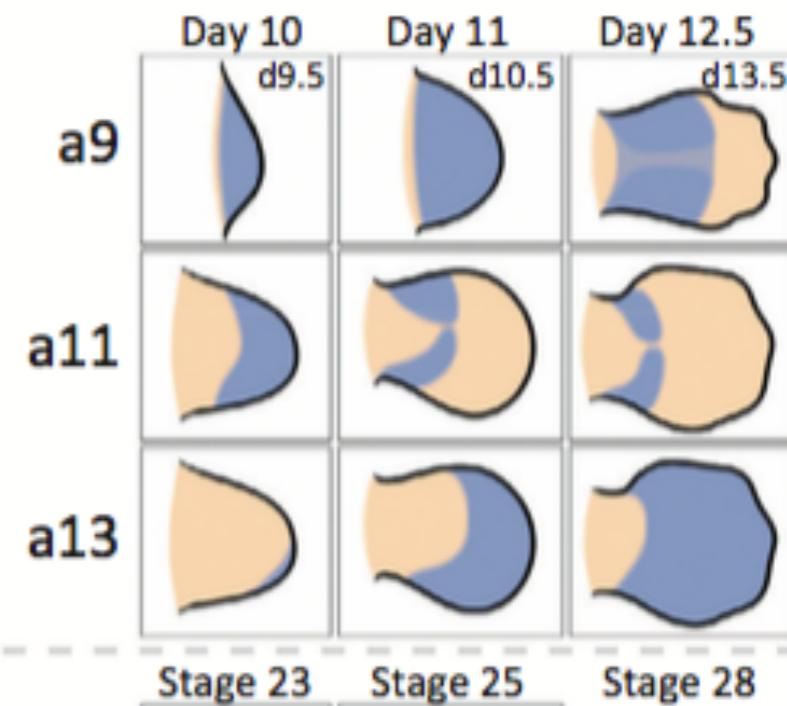
HoxD

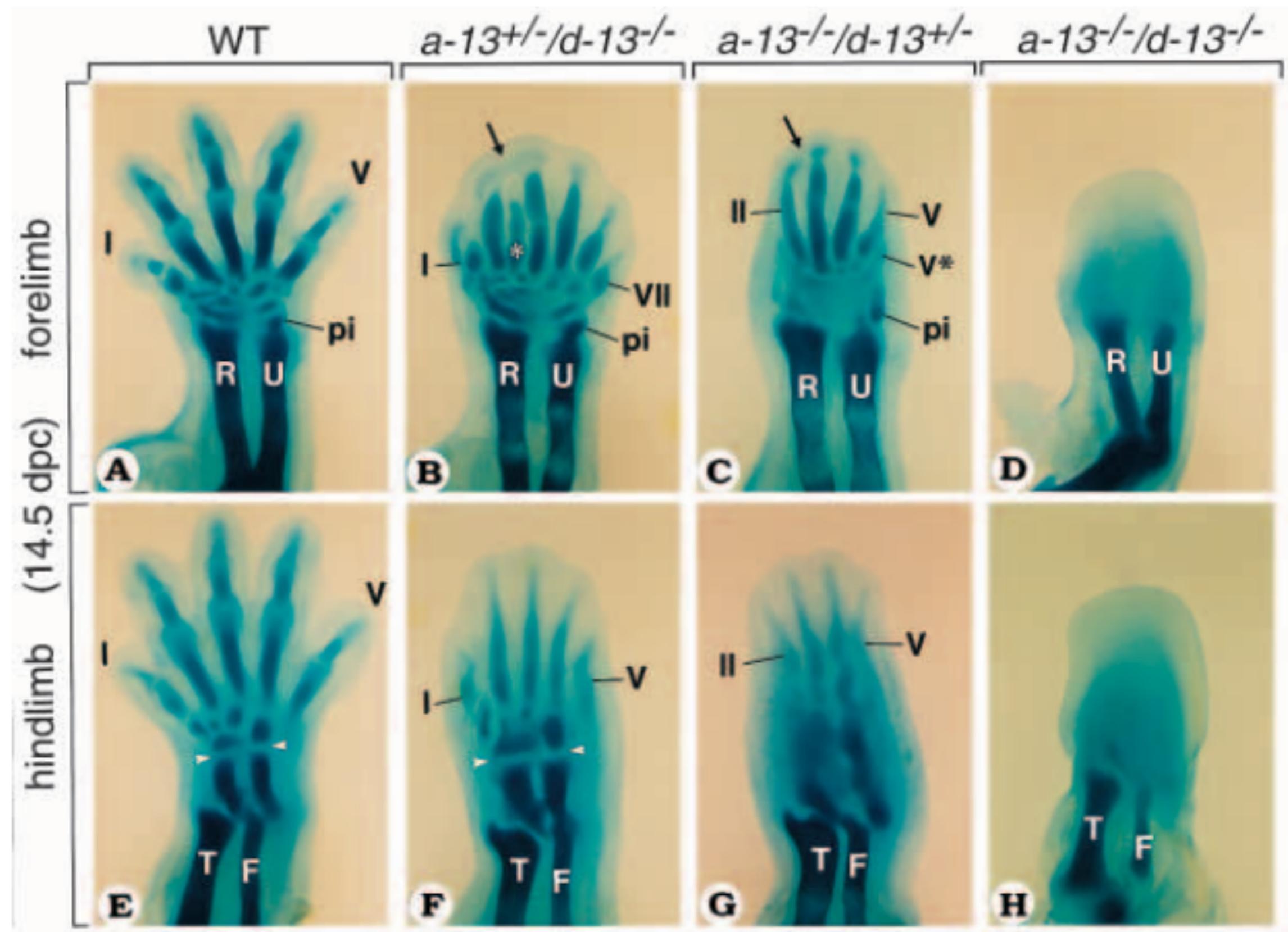


Mouse
(M. musculus)



HoxA





Family A

III-1



Family B

VI-7



Family C

IV-1



VI-6





Need to know about the role
of Hox13 in the development of fish fins

Looking for
traces of the autopod
in fish fins

Where is Hox13
expressed in zebrafish?

What is the **fate** of early
and late Hox cells?

What happens if we
knock out Hox13
genes?

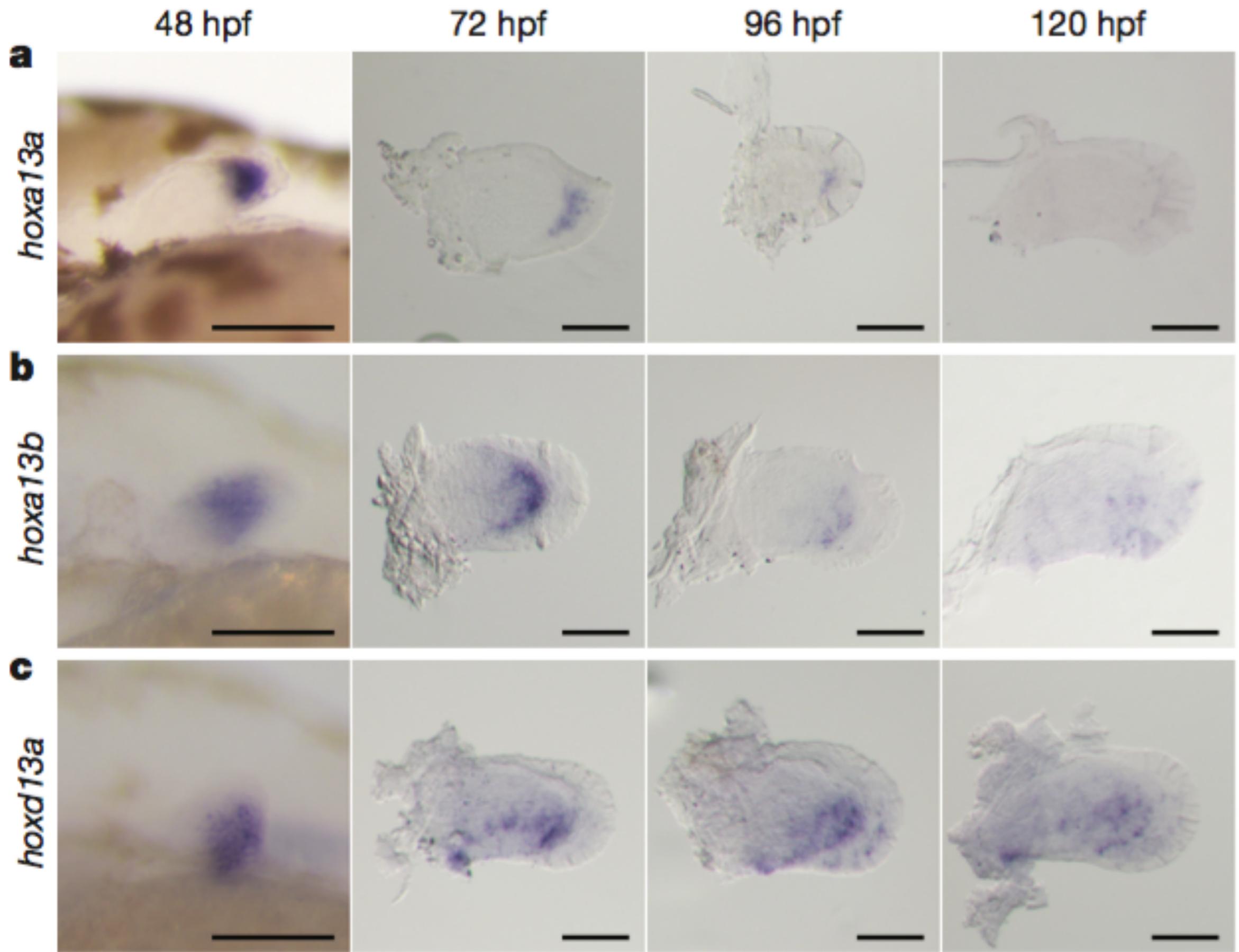
Where is Hox13 expressed in zebrafish?

What is the **fate** of early and late Hox cells?

What happens if we **knock out** Hox13 genes?

in-situ hybridization

Where is a gene expressed in a developing embryo?



What did they find?

Hox13 genes are expressed mainly in the distal parts of the developing limb bud

(but expression stops entirely by 10 days post-fertilization)

Where is Hox13
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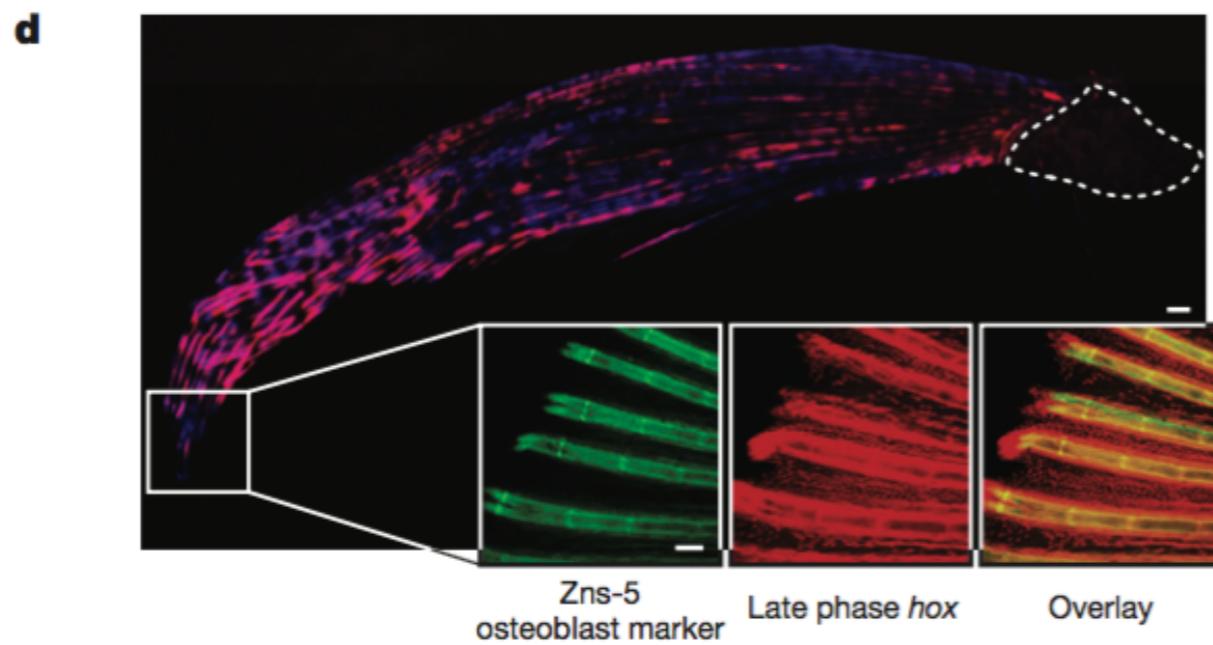
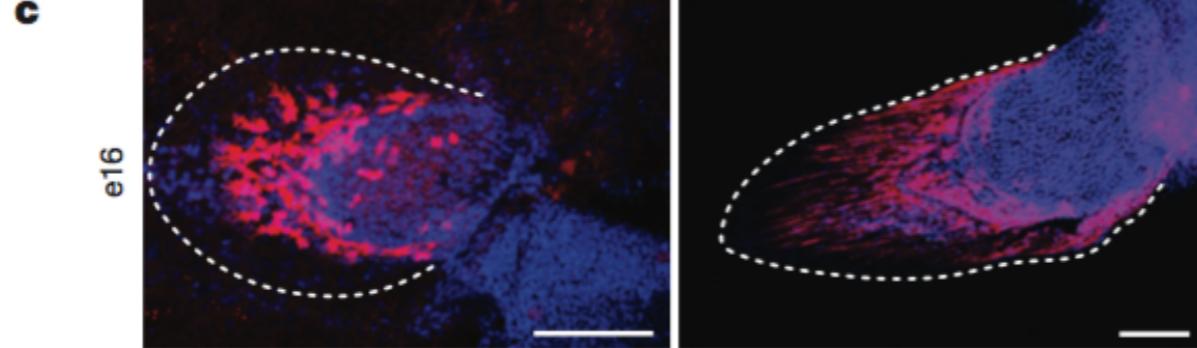
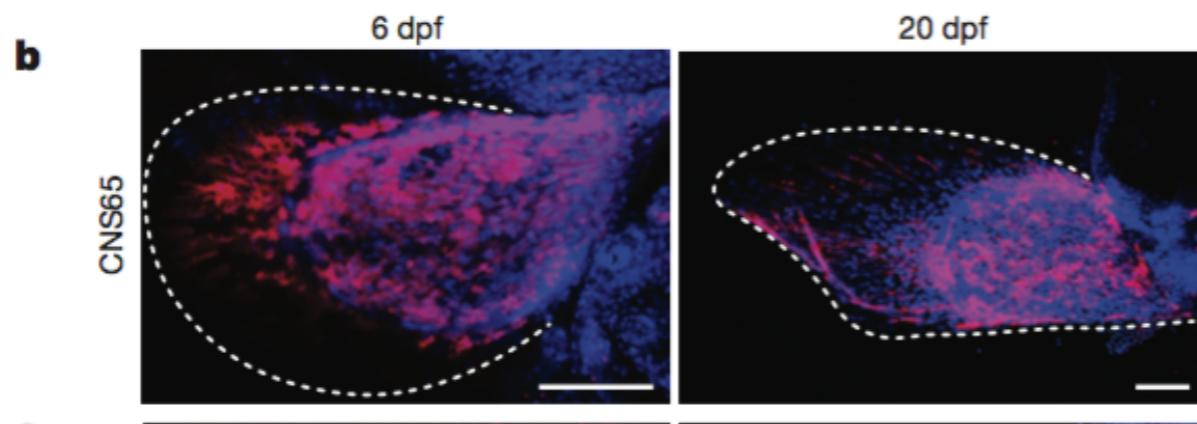
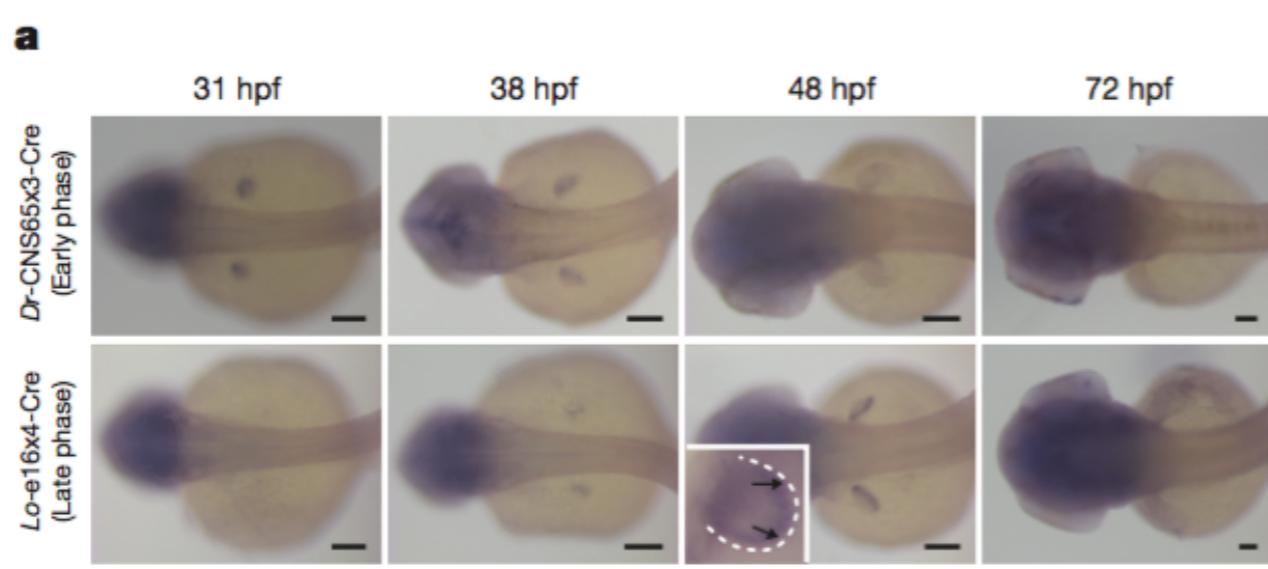
Where is Hox13
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What is the **fate** of early
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What happens if we
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genes?

fate mapping with mCherry

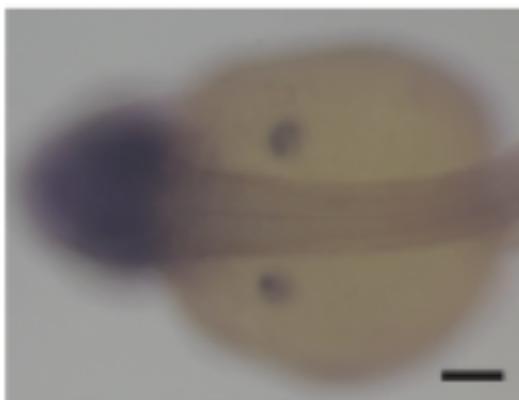
Track the fate of cells during development



a

Dr-CNS65x3-Cre
(Early phase)

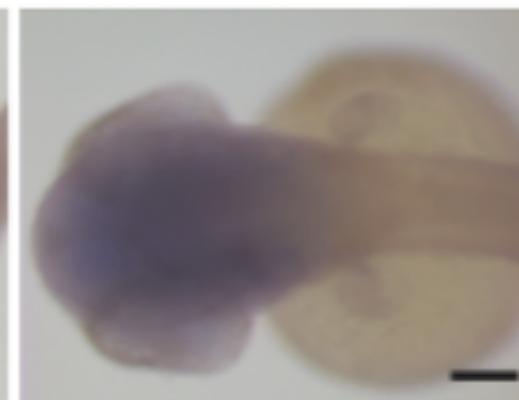
31 hpf



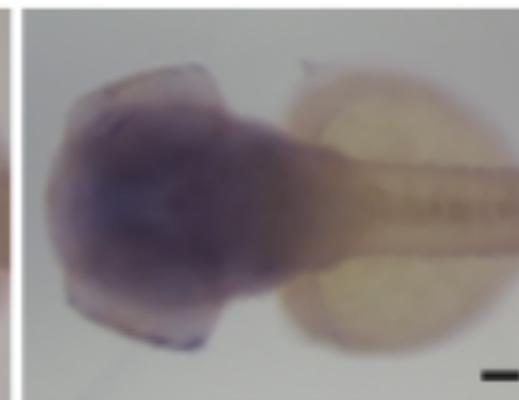
38 hpf



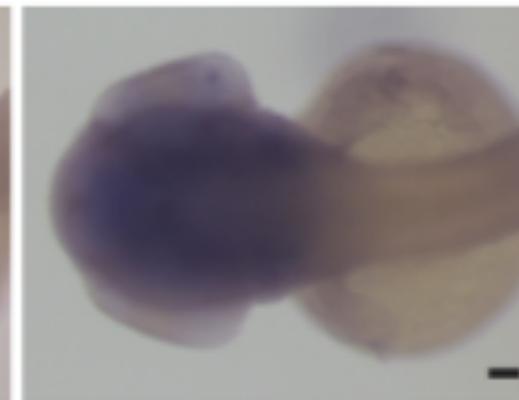
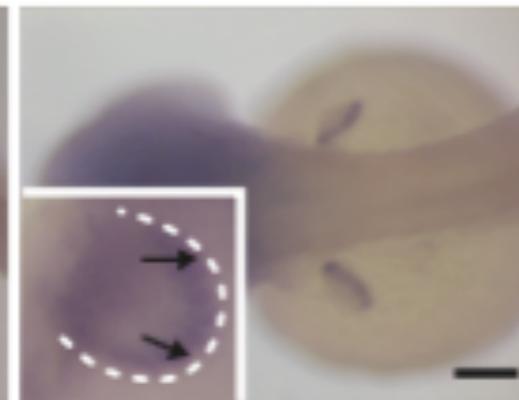
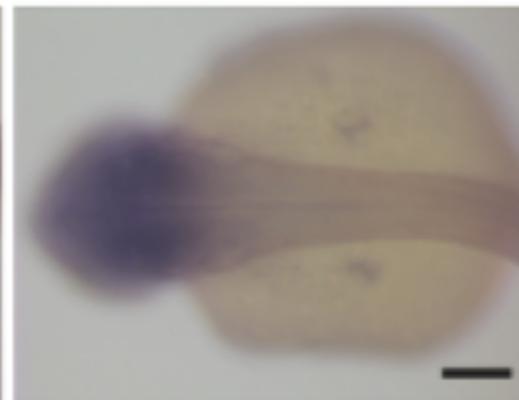
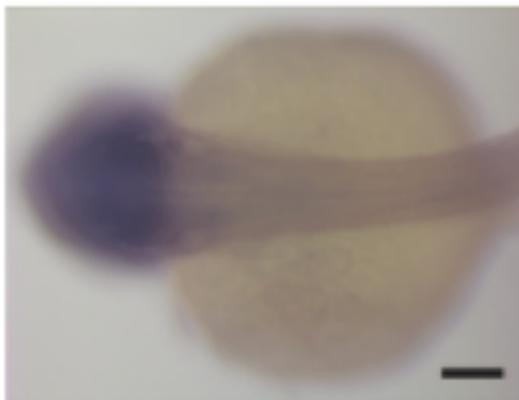
48 hpf

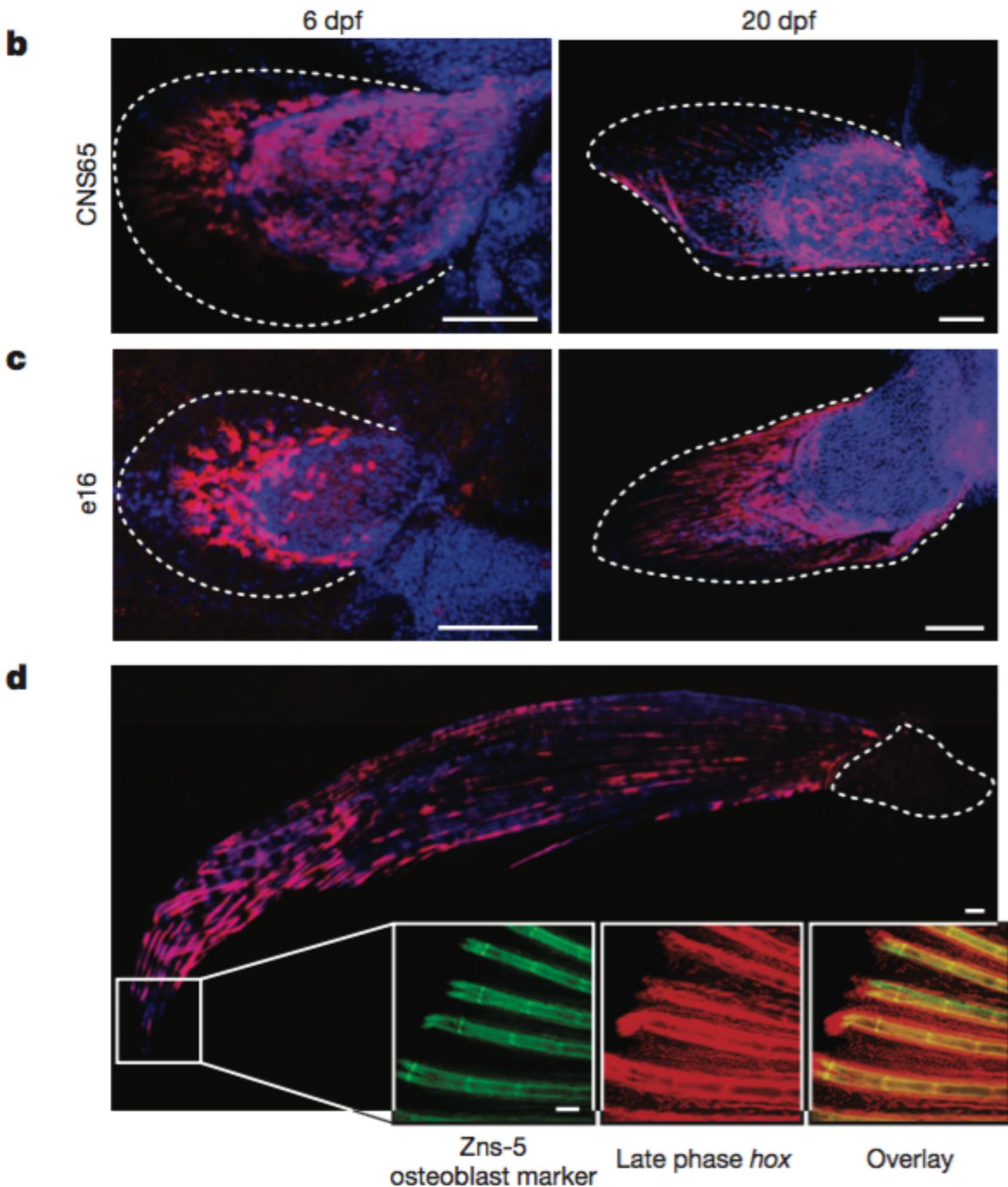


72 hpf



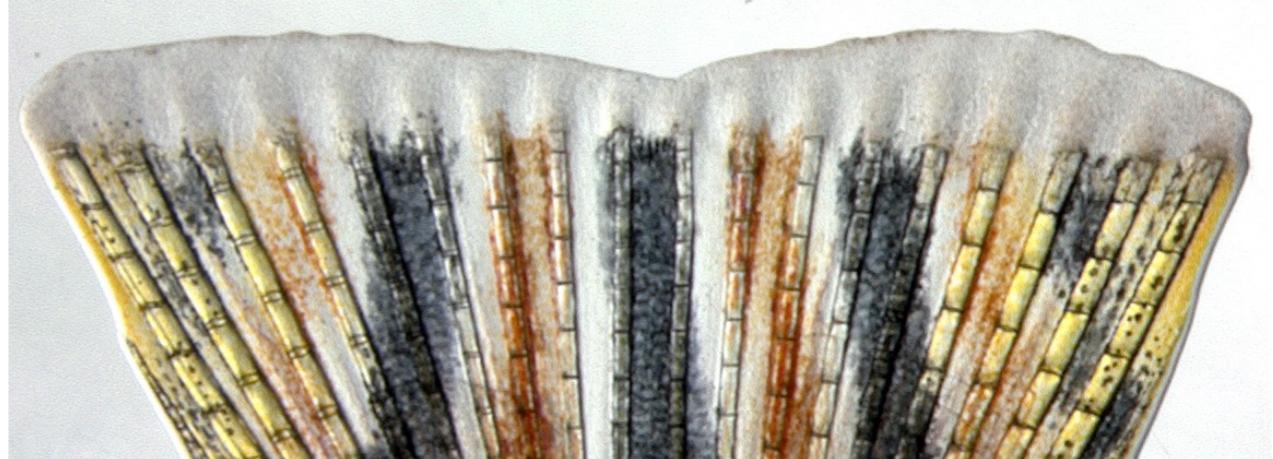
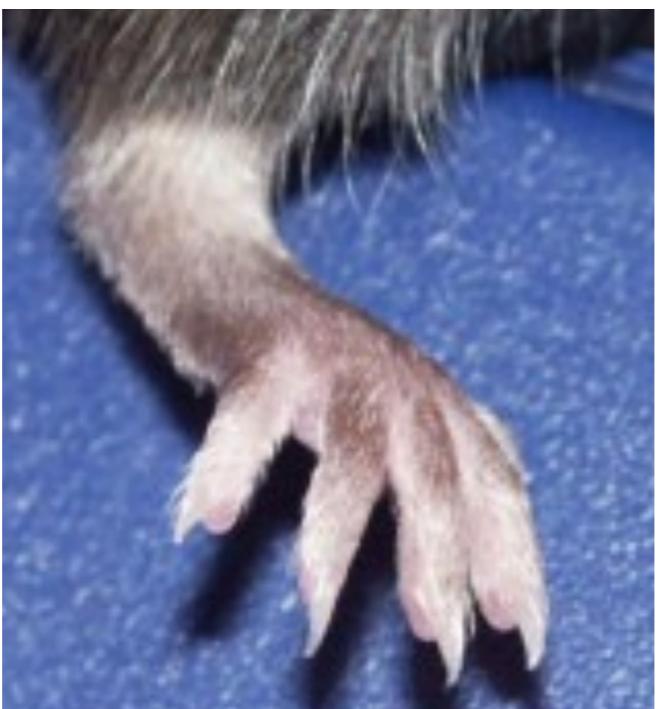
Lo-e16x4-Cre
(Late phase)





What did they find?

Late-phase Hox cells
(matching Hox13 expression pattern)
form the osteoblasts of the dermal rays



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genes?

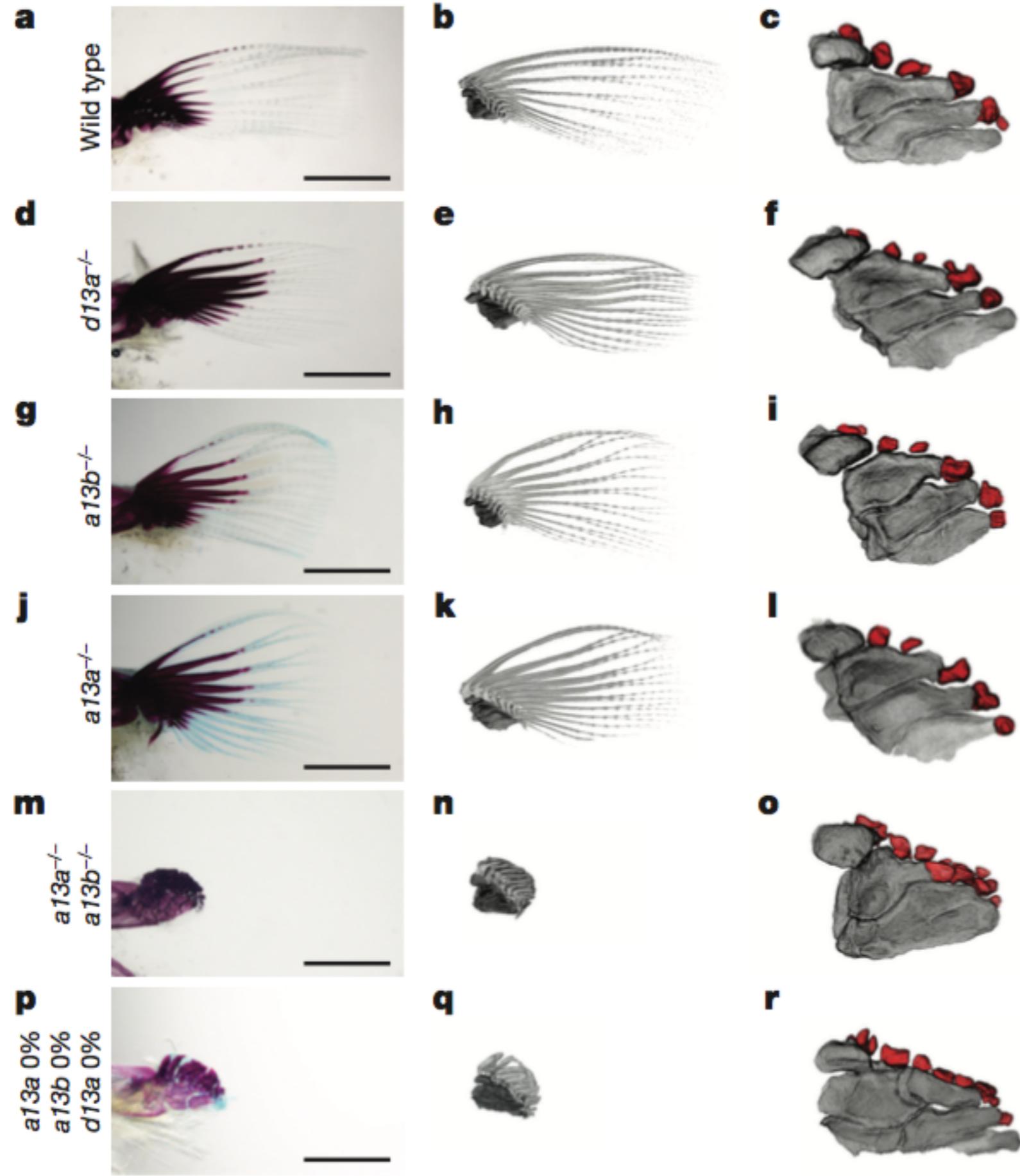
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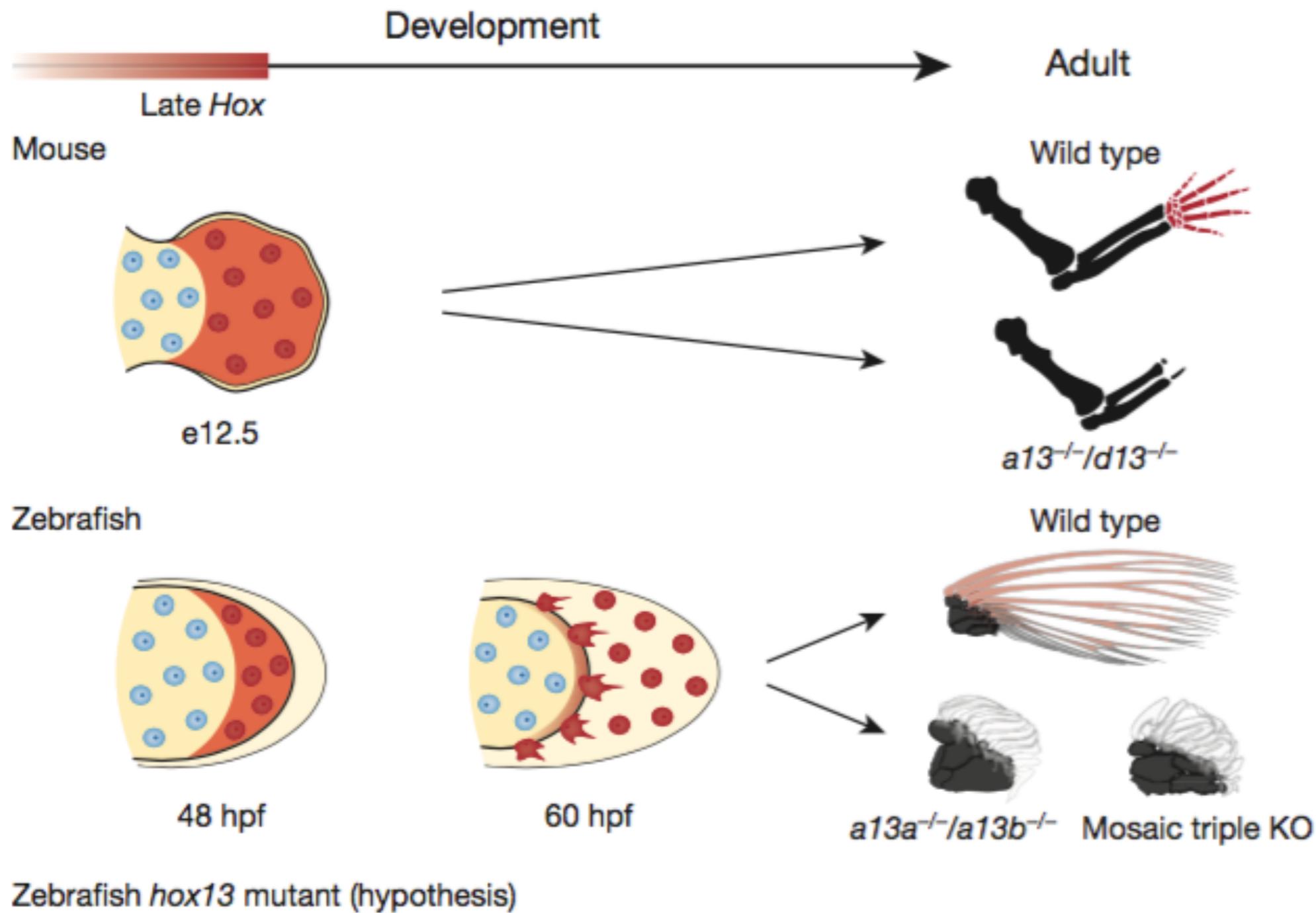
CRISPR interference

inactivate individual genes so that they are
not transcribed at all

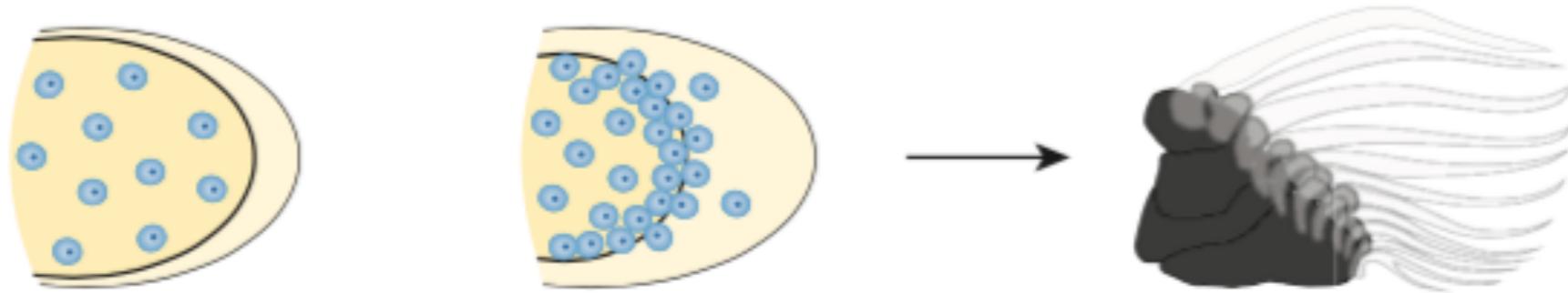


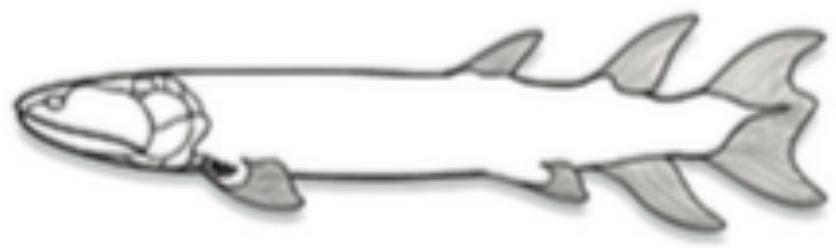
What did they find?

Knocking out Hox13 genes disrupts the fin rays
and also enlarges and alters endochondrial bones

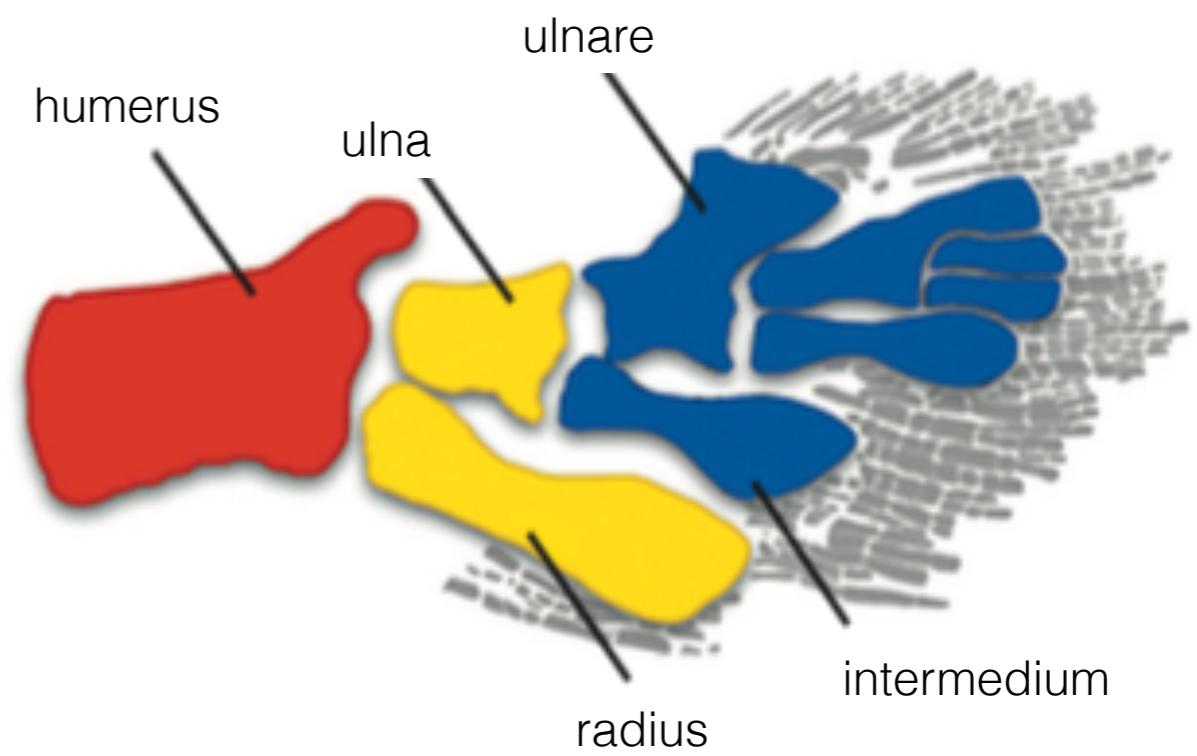


Zebrafish *hox13* mutant (hypothesis)





Eusthenopteron



Unexpected shared pattern in development

Single change can explain both key aspects
of the fin-to-limb transition

Two major trends underlie the fin-to-limb transition—the elaboration of endochondral bones and the progressive loss of the extensive dermal fin skeleton^{2,7,20}. In the combinatorial knockouts of *hox13* genes, which in tetrapods result in a loss of the autopod, distal endochondral radials were increased in number while fin rays were greatly reduced. As a common population of cells in the distal appendage is involved in the formation of rays and digits, the endochondral expansion in tetrapod origins may have occurred through the transition of distal cellular fates and differential allocation of cells from the fin fold to the fin bud¹⁸ (Fig. 4). The two major trends of skeletal evolution in the fin-to-limb transition may be linked at cellular and genetic levels.

Science

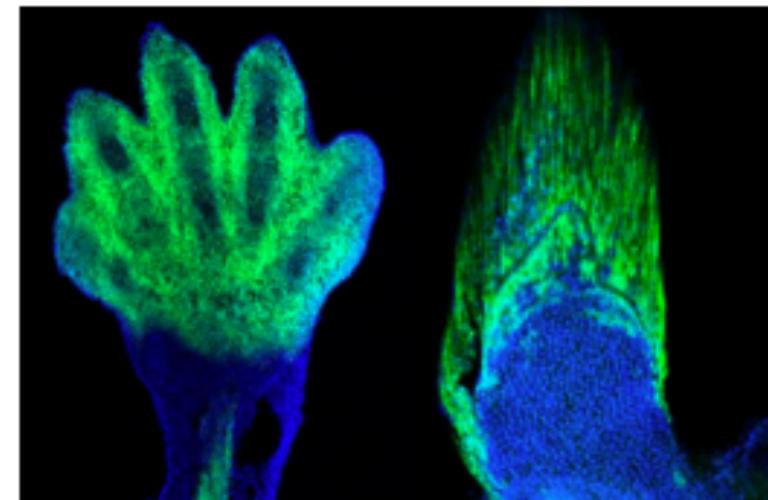
ENVIRONMENT | SPACE & COSMOS | HEALTH | TRILOBITES | SCIENCETAKE | OUT THERE



CRAIG COOK/UNDERSEA MEDICAL

Giant Coral Reef in Protected Area Shows New Signs of

1:12



MARIE KMITA AND ANDREW GEHRKE

MATTER

From Fins Into Hands: Scientists Discover a Deep Evolutionary Link

The findings by a University of Chicago team will help researchers understand how our ancestors left the water, transforming fins into limbs so they could move on land.

1d ago · By CARL ZIMMER